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A CIRCULAR POLARIZATION SELECTIVE SURFACE MADE OF RESONANT HELICES

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DEFENCE RESEARCH ESTABLISHMENT OTTAWA
REPORT NO. 1269

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Gilbert A. Morin
MIL SAT Communications Group
Space Systems and Technology Section

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ABSTRACT

A circular polarization selective surface (CPSS) is a surface that reflects one sense of circular polarization but transmits the other sense. While linear polarization selective surfaces (usually abbreviated PSS) are fairly common, CPSS's have attracted attention only recently. In this report, a new CPSS with improved characteristics is presented and potential applications are discussed.

This new CPSS is made of special square helices. Because the helices can be supported at their extremities, this CPSS does not need a dielectric support as other CPSS's do and therefore can be made more transparent.

The response of the CPSS to a plane wave excitation was simulated using the method of moments for thin wires. Mutual coupling and losses were taken into account. Simulation results show that the radar cross-section of the surface to one circular polarization is 50 times higher than to the other polarization.

A CPSS has been fabricated. Transmission measurements show that the surface permits most of one circular polarization to pass through while rejecting the other polarization. The rejection ratio is more than 15 dB. These results are in good agreement with the theory.

Three potential applications of CPSS's in the field of reflector antennas are reduction of sub-reflector blockage in dual reflector antennas, frequency reuse through polarization diversity in a dual-offset reflector, and design of a mirror antenna for circular polarization.

RÉSUMÉ

Une surface sélective à polarization circulaire (SSPC) est une surface qui réflète un sens d'une onde polarizée circulairement tout en transmettant l'autre sens. Bien que les surfaces sensibles au ondes linéaires soient très répandues, les SSPCs n'ont attirés l'attention que très récemment. Dans ce rapport, une nouvelle SSPC avec des charatéristiques intéressantes est présentée. Certaines applications potentielles sont aussi discutées.

Cette nouvelle SSPC est fabriquée à partir d'hélices spéciales de forme carrée. Parce que des hélices sont utilisées au lieu d'éléments disconnectés comme dans les autres SSPCs connus, il est possible de fabriquer une SSPC sans support diélectrique, ce qui augmente la transparence du SSPC.

La réponse du SSPC à une onde plane a été simulée à l'aide de la méthode des moments pour fils minces. Le couplage mutuel et les pertes sont inclus dans la simulation. Les résultats montres que la section efficace radar de la surface à une onde polarizée circulairement est 50 fois plus grande pour une polarization que pour l'autre.

Une SSPC a été fabriquée. Des mesures de transmission ont démontré que la surface transmet presque complètement une polarization alors qu'elle réfléchit presque complètement l'autre. Le rapport des deux transmissions est de 15 dB. Ces résultats s'accordent bien avec la théorie.

Trois applications possibles des SSPCs dans le domaine des antennes à réflecteurs sont discutées. Ces applications sont évidemment pour les antennes polarizées circulairement. Une antenne Cassegrain pourrait avoir un sous-réflecteur fait en SSPC ce qui éliminerait le bloquage. Une antenne parabolique à double réflecteurs assymétriques peut réutiliser la même fréquence en utilisant les deux polarizations qui sont séparées par une SSPC. Enfin, il est possible de fabriquer une antenne miroir pour onde circulaire en utilisant un réflecteur en SSPC .

EXECUTIVE SUMMARY

In communications and radar, circular polarization (CP) as opposed to linear polarization (LP) is used more and more often because of some of its characteristics. One important characteristic is that neither the antenna nor the feed has to be rotated around its pointing axis to "align" the polarization as is the case for linear polarization. This is particularly advantageous for mobile communications where one end or both ends of the communications link are frequently, if not constantly moving. Another advantage of circular polarization is that multipath is often of the opposite polarization and is therefore naturally rejected by the receive antenna. LP antennas often use a polarization grid to enhance its polarization purity. No such polarization grid was known for CP until approximately 10 years ago when a DREO contractor discovered what was thought to be the first "Circularly Polarized Selective Surface or CPSS". In the following years, 3 new CPSS's were discovered, although it was also found that one of them was a "reinvention" of an existing French patent that was not widely publicised. These CPSS's offer the potential of improving CP antenna characteristics not only in ways similar to LP antennas but also in ways that have no equivalent for LP.

The objective of this report is to present a CPSS that was discovered at DREO and for which a patent has been obtained. A CPSS is a surface that reflects one sense of circular polarization but transmits the other sense. This new CPSS has an advantage over other CPSS's in that it does not need a dielectric slab for support. This CPSS is made of wires forming square helices which can be supported at their extremities to eliminate the need for a dielectric which would degrade its performance.

The response of the CPSS to a plane wave excitation was simulated using the method of moments for thin wires. Mutual coupling and losses were taken into account. Simulation results show that the CPSS reflects totally one circular polarization and is almost transparent to the other polarization.

A CPSS has been fabricated at 7 GHz and transmission measurements showed that the surface acts in good agreement with the theory.

Three potential applications of CPSS's in the field of reflector antennas are described. One is the reduction of sub-reflector blockage in dual reflector antennas, to increase gain and reduce sidelobe levels. Another application is for frequency-reuse through polarization diversity using a dual-offset reflector. And finally, it is possible to design a mirror antenna for circular polarization. This type of dish antenna can be steered faster than a regular dish antenna and is advantageous for applications where higher steering velocity is required but phased arrays are too expensive.

More development work would be needed to study curved CPSS's since only flat ones have ever been built. Also, the performance of all known CPSS's degrades with angle of incidence of the incoming wave. This is an important drawback that must be addressed and reduced. Finally, some of the potential applications should be developed to investigate practical considerations like performance improvement and cost.

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1.0 INTRODUCTION

A Circular Polarization Selective Surface (CPSS) is an electromagnetic surface that reflects one sense of a circularly polarized (CP) wave but is transparent to the other sense. While parallel-wire grids used as linear polarization selective surfaces have been known and used for a long time, CPSS's have been a relatively unknown device.

A left CPSS is defined as a CPSS that reflects a left-handed circularly polarized (LHCP) wave, and conversely for a right CPSS. To better understand the function of a CPSS, Figure 1 compares the interaction of CP waves with a perfect conducting plane and a left CPSS. Figure 1a shows a perfect conducting plane with an impinging LHCP wave. Upon reflection, the sense of the wave is changed to right-hand (RHCP) because of the boundary conditions. An impinging RHCP wave would also reverse its sense upon reflection. In Figure 1b, a LHCP wave impinges upon a left CPSS and is reflected without any change in polarization sense. A RHCP wave passes through the CPSS unchanged. This kind of behaviour can be very useful to design new antenna types with desirable characteristics. Figure 2 shows a schematic of a typical CPSS **[Tilston & Towne[12]]** based on **Pierrot**'s design[6]. It is made of a low-loss dielectric plate one-quarter wavelength in thickness. The dielectric is subdivided in a square pattern containing one CPSS element each. Each cell element is represented by a short line and will be described later. The cell is square and measures half-a-wavelength wide. The pattern seen on both sides of the dielectric plate is identical except for a rotation of 90 degrees. The surface is therefore symmetrical with no distinguishable side.

1.1 Background History

Historically, the first reported invention of a CPSS was that of **Pierrot[6].** The cell element used by Pierrot is shown in Figure 3. This invention was not well publicised and work started at DREO on CPSS in the mid-eighties not knowing that any such surface existed. **Tilston et al.[11]**, discovered what was thought to be the first CPSS. His cell element is shown in Figure 4. The CPSS is made of a planar array of half-wave dipoles on each side of a dielectric slab that is used only for support. Transmission lines, crossing through the slab, connect the dipoles together. At frequencies of 1 GHz and higher, the transmission lines are increasingly difficult to fabricate because of their small sizes, and a simpler design is desirable. The main difficulty with the transmission lines is that they are one half-wavelength long and the dielectric support is only one quarter-wavelength thick. If the transmission lines are not folded, different dielectrics must be used for the slab and the transmission lines. This is a strong disadvantage since in a practical CPSS, thousands or tens of thousands of cells are needed. Further work was done at DREO by the author to design a CPSS that would be simpler and easier to fabricate. Two CPSS's were discovered (one of which was "rediscovered"). The first one **[Morin[2],**

Morin[3], **Morin**[4]] was Pierrot's CPSS as it was found later during the patenting process. It does not use transmissions lines, and printed circuit technology (see Figure 5) can be used for fabrication from a few GHz up to about 30 GHz. The second CPSS (described in chapter 3 and shown in Figures 17, 18, and 19) was a novel design with interesting properties and was patented [**Morin**[5]].

Two contracts were issued in 1989 to build and test different CPSS designs [**Tilston**[12], **Chow**[1]]. A very useful improvement to the original Tilston's design [**Tilston**[11]] was found by **Chow**[1] which made the CPSS much easier to fabricate. An implementation in microstrip technology is shown in Figure 6. Pierrot's design was also investigated experimentally and 2 models built and tested.

After this work, it was decided to move directly to applications and a contract was issued to build a circularly polarized Cassegrain antenna with reduced blockage [**Roy**[9]] using a CPSS as a sub-reflector. The work was partially successful because the CPSS used did not have very good performance when the incoming wave was hitting the surface at angles larger than 15 degrees from normal. A better CPSS had to be designed. Due to other priorities, the work on CPSS was halted before the investigation could be completed.

In this paper, a new CPSS, for which a patent was issued [**Morin**[5]], is reported. It has some desirable characteristics that are not found in any other CPSS.

1.2 Theorems for CPSS

To understand how CPSS's work, it is useful to look at some theorems. In the following, we will assume that the CPSS is an infinite planar slab of finite thickness. There is more than one type of CPSS that can be defined. For instance, one could use active components to fabricate a CPSS. However, in this report we have restricted CPSS's to the simplest type. Moreover, all the published CPSS's are of this type. Let's assume that a CPSS is reciprocal, lossless and perfectly selective. Let's assume also that the CPSS has indistinguishable sides which means that by looking at the CPSS from one side, then the other, one cannot see any difference. Finally, we will assume normal incidence for any wave impinging on the CPSS (from either side). Three theorems can be derived.

Theorem 1: "The CP wave <u>reflected</u> by a CPSS will be of the same polarization as the incoming wave". This theorem can be proven by showing that if the sense of polarization was changed then the surface would be a perfect conductor. Suppose a RHCP wave is reflected from a surface as a LHCP wave, then by reciprocity, a LHCP wave will be reflected as a RHCP wave. In this case, the surface does not transmit any wave and is equivalent to a perfect conductor. Therefore, a CPSS cannot change the sense of polarization of the incident wave.

Theorem 2: "The wave transmitted by a CPSS will be of the same polarization as the incoming wave". This can be proven as follows. If a surface reflects RHCP on one side and has indistinguishable sides (as defined above), then it reflects also RHCP on the other side. Therefore, LHCP must be transmitted as LHCP otherwise it would violate reciprocity.

Theorem 3: "An infinite CPSS cannot be made of an infinitely thin surface". In other words, an infinite CPSS must have a finite thickness. This can be shown as follows. An infinitely thin surface made of dielectric and conductors scatters identical waves on both sides except that the sense of polarization is reversed. If a RHCP wave hits such a surface, the scattered wave in the transmitted direction would have to be RHCP (and 180 degrees out of phase) to cancel the incoming wave, but it would also have to be RHCP in the reflected direction according to Theorem 1. The polarization would be the same in both directions which is not possible for an infinitely thin surface. Therefore, a CPSS must have a finite thickness.

1.3 Applications

There are several potential applications for CPSS's. Three are presented here.

Figure 7 shows a Cassegrain antenna with a CPSS sub-reflector that eliminates blockage. A LHCP wave coming out of the horn is reflected by a left CPSS sub-reflector as a LHCP wave. This LHCP wave bounces off the main reflector as a RHCP wave and goes through the sub-reflector which is transparent for the polarization sense. Therefore the blockage is eliminated which will increase the gain and reduce the sidelobe level. With this technique, large sub-reflectors can be used with minimal degradation of the antenna performance. This application was investigated in a contract **[Roy, Shaker, & Shafai[9]]** and it was found that the CPSS degrades rapidly as the angle of incidence of the incoming wave moves away from normal. Further investigation is required to design CPSS's with variable angles of incidence and to develop fabrication techniques that reduces the sub-reflector cost.

Figure 8 shows a CP dual-reflector antenna with a CPSS sub-reflector. Both right and left polarization's can be used at the same frequency if the sub-reflector is a CPSS. In this illustration, there is a left CPSS that acts as a reflector for the LHCP feed but is transparent for the RHCP feed. The main challenge in designing such an antenna is probably in achieving sufficient level of polarization selectivity required by the system. If both feeds are "receive" (or "transmit"), this appears feasible. However, if one feed is "receive" and the other is "transmit", a very high degree of selectivity is required and more work is required to determine the limitations of CPSS's.

Figure 9 shows a mirror antenna for circular polarization. The left wave coming out of the horn is reflected off the main CPSS reflector. It is then reflected off the flat plate as a right wave, and goes through the main reflector and/or the radome unimpeded. The main advantage

of this design is that the flat plate or mirror is steered instead of the parabolic reflector which is integrated into the radome. Any rotation of the mirror produces twice the rotation for the beam direction. Because of this property, the mirror rotates along 45 degrees in all directions to cover the whole hemisphere and therefore it does not need a three-axis pedestal as commonly used for parabolic reflectors. The result is a much faster scan rate and a less complex and much lighter scan mechanism.

2.0 PIERROT'S CPSS

It is very instructive to look at Pierrot's CPSS design **[Pierrot[6]]** and performance before looking at the new design. They have many features in common and Pierrot's design was extensively studied at DREO since it was rediscovered here.

2.1 Description

A CPSS using Pierrot's design was designed built and tested in-house. The nominal frequency was 7.5 GHz. This CPSS was also simulated on the computer. The results of the computer simulation and the experimental investigation will follow a brief description of the design.

The CPSS is made of a square slab of dielectric, one-quarter wavelength thick, with CPSS cells forming a square grid. Each cell contains an element as shown in Figure 3. The element is made of a one-wavelength long wire bent according to the figure. A LHCP plane wave propagating in the +z-direction will excite the one-wavelength resonance of the wire while a RHCP wave will not. A right CPSS element is the mirror image of the element shown in Figure 3.

Figure 10 explains the behaviour of a left CPSS element in the presence of a LHCP wave. It is useful to decompose the wave into two linearly polarized components as shown in the figure. Assuming the wave is propagating in the +z direction, the y-component is a quarter wavelength ahead of the x-component. Each component, x- and y-, strikes one wire segment, a and c respectively. Two full-wavelength resonances are excited, one from each end of the wire. Because of the phase relationship between the x- and y-components and the position of the wire segments, both resonances are excited in phase and the currents add up. However, for a RHCP wave, the y-component is 180 degrees out of phase, compared with a LHCP wave, and the two resonances cancel each other.

2.2 Computer Simulation

To show this effect, a modified moment method program **[Richmond[7]]** was used to calculate the scattering cross-section (SCS) of a cell element one-wavelength long at 1.0 GHz. Figure 11 shows the result for both LHCP and RHCP incoming waves. The SCS at resonance for LHCP is about 40 times larger than for RHCP. Resonance is shifted to higher frequencies by about 2%. The normalization of the SCS was chosen as follows. The SCS of a very large and

totally reflective surface is twice the surface area. Since the CPSS is also reflective (for one sense), then its SCS will be twice its surface area. The cell dimension is half-wavelength on the side to form a "full" array. Therefore, by selecting twice the cell area as the normalization factor, the normalized element SCS must be about 1.0 to be useful. This is the result obtained in Figure 11. Of course, mutual impedance between the cells and the direction in which the scattering is made may affect the results so CPSS with several cells must be investigated.

A 25-cell CPSS was simulated. The cell elements were organized in a 5X5 square array. The cell size is half a wavelength by half a wavelength. Using the same program as above, the SCS has been calculated for 25-cell array and the result is shown in Figure 12. The normalization factor is twice the array surface area as discussed above. The ratio of the left and right SCS at resonance is now 84. There is a 6% shift in the resonant frequency due probably to mutual coupling. The SCS for the LHCP wave is about 1.0 as desired.

Figure 13 shows the bistatic cross-section of the same CPSS. The scattered power is concentrated in the direction normal to the surface and there is minimal radiation in the plane of the CPSS. This is the desired result.

2.3 Experimental Results

A left CPSS made of 100 cells was fabricated and measurements were made. The setup used is shown in Figure 14. The CPSS was placed between two quad-ridged horns (which are dual-polarized linearly) and transmission measurements were made for both RHCP and LHCP waves. CP waves were obtained by using quadrature hybrids to feed the two ports of each horn with proper amplitude and phase. The horns were 20 cm from the surface which placed them in the far-field of each other. However, they were close enough to the surface for the receive horn to be in the "shadow" of the surface. The transmission measurement was done using a vector network analyzer (Wiltron 360).

The measurement sequence proceeded as follows. First the horns were connected for LHCP waves. A transmission measurement was made without the CPSS. Then the CPSS was inserted between the horns and a new transmission measurement was made on the same graph. The sequence was repeated for RHCP. Figure 15 shows the result for LHCP. The response when the CPSS is present shows a rejection of the signal of more than 20 dB at 7.5 GHz. In other words, the surface does not let the LHCP wave go through. In Figure 16, measurements for RHCP are shown. It is shown that the surface is almost transparent to the wave. The difference between the reference signal and the transmitted signal being less than 1 dB.

The surface behaved as expected.

3.0 A NEW CPSS MADE OF HELICES

The new CPSS described in this section has many similarities with the previous one although it does not have resonant elements.

3.1 Description

The new CPSS is made of parallel helices. The main advantage it has over other designs is that it can be supported by the extremities of the helices and does not require a dielectric slab to support it. The other CPSS designs need a dielectric support because all the elements are disconnected. The dielectric affects the performance of the surface by causing reflection and losses and also complicates the design because the dielectric permittivity has to be taken into account.

The special helix is shown in Figure 18 with an "element" shown in Figure 17. The length of each wire element is one quarter-wavelength. Since the elements are connected together to form a helix, they do not operate independently as in Pierrot's design although there is a strong resemblance.

The operation of the helix can be easily understood by looking at Figure 18. An LHCP wave is illustrated with its 2 linear components, the x-component (vertical) and the y-component (horizontal). The x-component is lagging behind the y-component (for RHCP it would be the other way around). The incoming wave is normal to the plane of the CPSS. Notice that the vertical wires (x-axis) are all in the front plane of the CPSS and the horizontal wire are all in the back plane. The x-component of the wave hits the vertical element of the helix and induces a current. The y-component hits the horizontal element and also induces a current. This current flows in the wire to the front of the plane where they add (in amplitude and phase) with the current induced by the x-component. Because the wire length between the middle of the back segment to the middle of the front segment is a half-wavelength, the current induced on one segment in reversed in direction when it reaches the other segment. In the case of Figure 18, the currents cancel out because they are exactly 180 degrees out of phase. Since there is no current flowing, the structure appears transparent. For a RHCP wave, the currents would add up in phase and create a strong resonance which would effectively reflect the wave back.

Several helices were assembled in one plane to form a CPSS as shown in Figure 19. Each segment length was 1.5 cm. Each helix was 30 cm. long. The separation between helices was 2.1 cm. The total CPSS surface area was 19x30 cm^2.

3.2 Computer Simulation

A simulation was done for the helix CPSS as for Pierrot's CPSS. The normalized cross-section is shown in Figure 20. The ratio of RHCP cross-section over LHCP cross-section is approximately 50 which is very good and shows that the surface behaves as expected. The normalized cross-section is 2.4 which means its cross-section is 2.4 times larger than the surface area occupied by the helix. In Pierrot's design, the cross-section was 1.1. The helix has almost double the cross-section compared to Pierrot's design because it also has twice the number of cells per unit area. This suggests that wider spacing than half-wavelength between helices could be used although at the risk of generating grating lobes for off-normal incidence.

3.3 Experimental Results

A RHCP surface, with the dimensions given above, was fabricated and tested the same way as the previous CPSS. The helices were supported by a quarter-inch foam to simplify fabrication. The results are shown in Figures 21 to 23. Figure 21 shows the transmitted signal with no CPSS present. Figure 22 shows the transmitted signal when the CPSS is inserted between the horns and the polarization is set to RHCP. The marker on the graph indicates the peak of the rejection band. The CPSS is resonating at about 6.8 GHz and rejects the signal by about 15 dB. The nominal design frequency was 7.5 GHz. This shift is probably mostly due to mutual coupling. Figure 23 shows the transmitted signal for LHCP. The signal goes through without visible attenuation.

4.0 CONCLUSION

This paper has described a new CPSS that is easy to fabricate and that has excellent electrical characteristics. Its main advantage over other CPSS's is that it is the only known CPSS that can be made self supporting except at the rim. This is an important advantage since the dielectric support of the other CPSS degrades the performance mostly because of surface reflection when the CPSS is supposed to be transparent. We have fabricated and tested one helix CPSS and found that the experimental results confirmed the theoretical findings.

Future development work is needed to make CPSS more practical. Curved CPSS's must be investigated since only flat ones have ever been built. Also, the performance of all known CPSS's degrades with angle of incidence of the incoming wave. This is an important drawback that must be addressed and mitigated or overcome. Finally, some of the potential applications should be developed to investigate practical considerations like performance improvement and cost.

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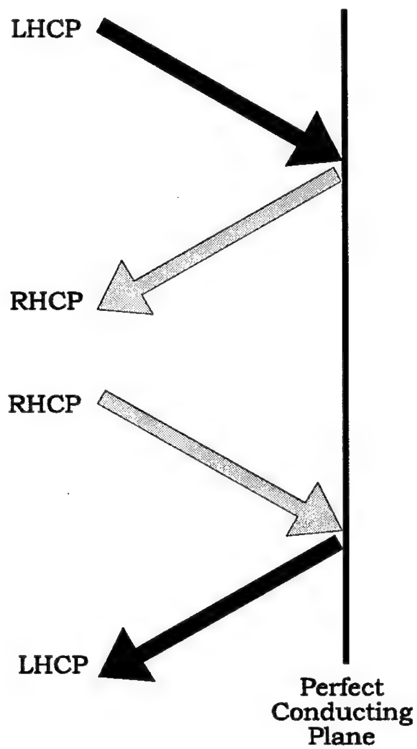

Figure 1a.

Interaction of circularly polarized waves with a perfect conducting plane.

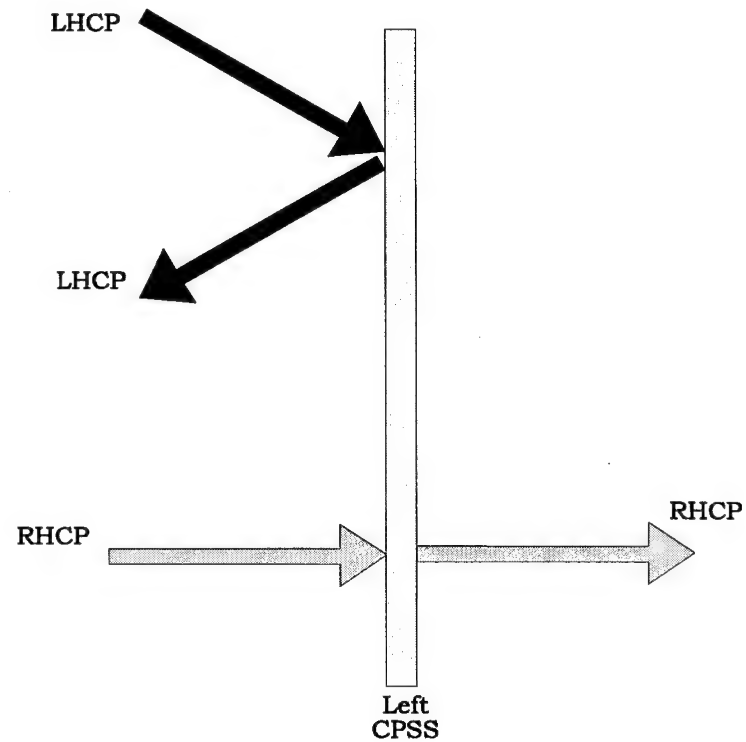

Figure 1b.

Interaction of circularly polarized waves with a left CPSS.

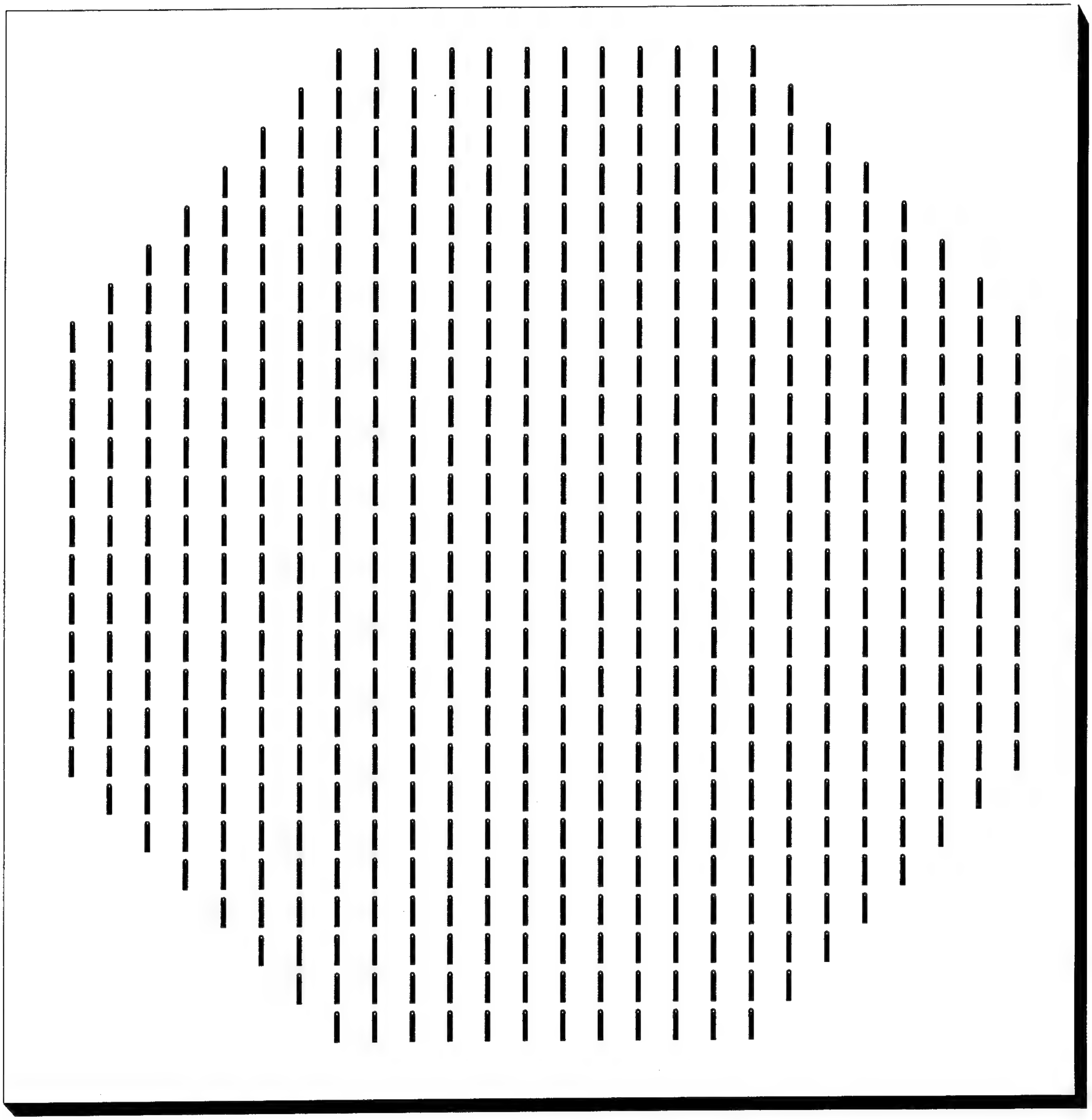

Figure 2. Drawing of a CPSS using Pierrot's design as seen from one side of the dielectric sheet. The other side is identical except for the wires being rotated by 90 degrees.

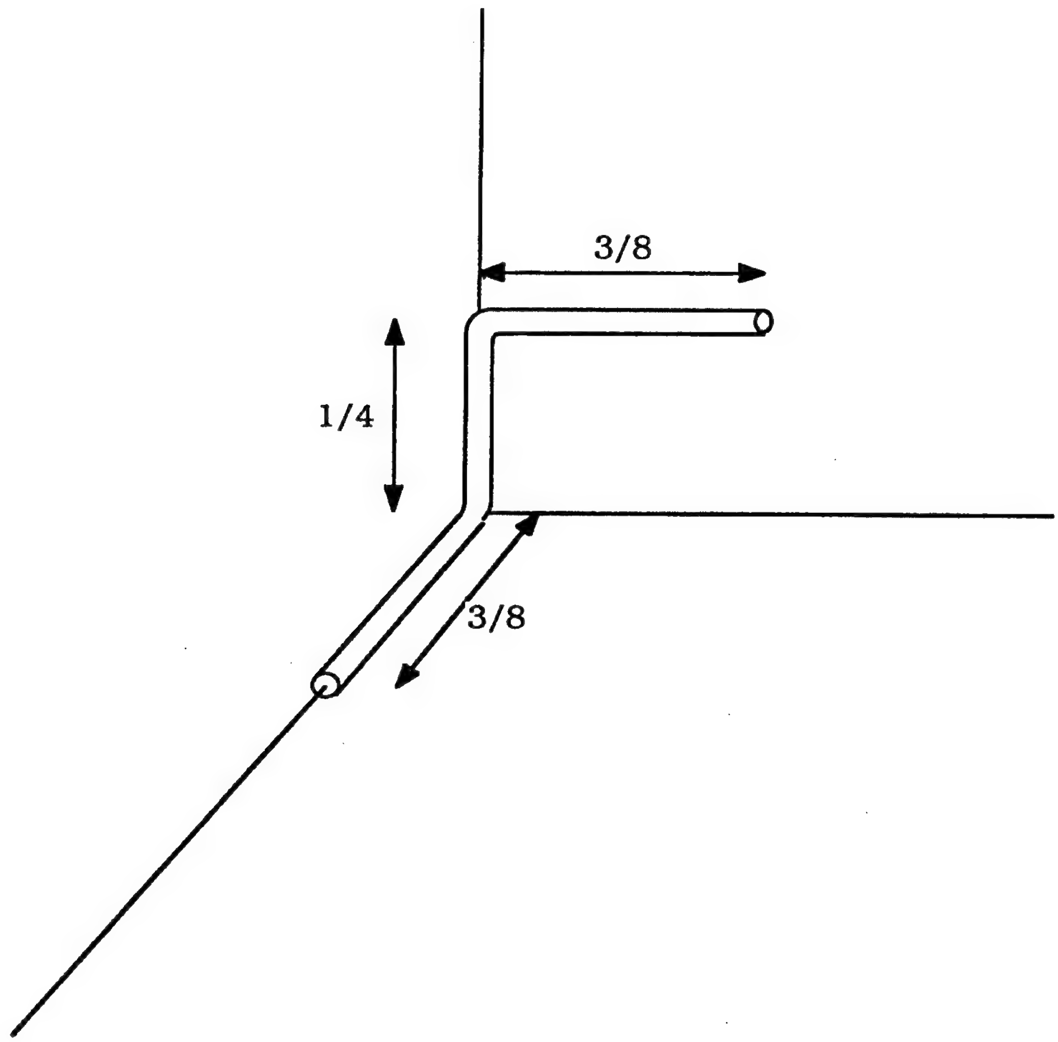

Figure 3. Left CPSS element (lengths are in wavelengths).

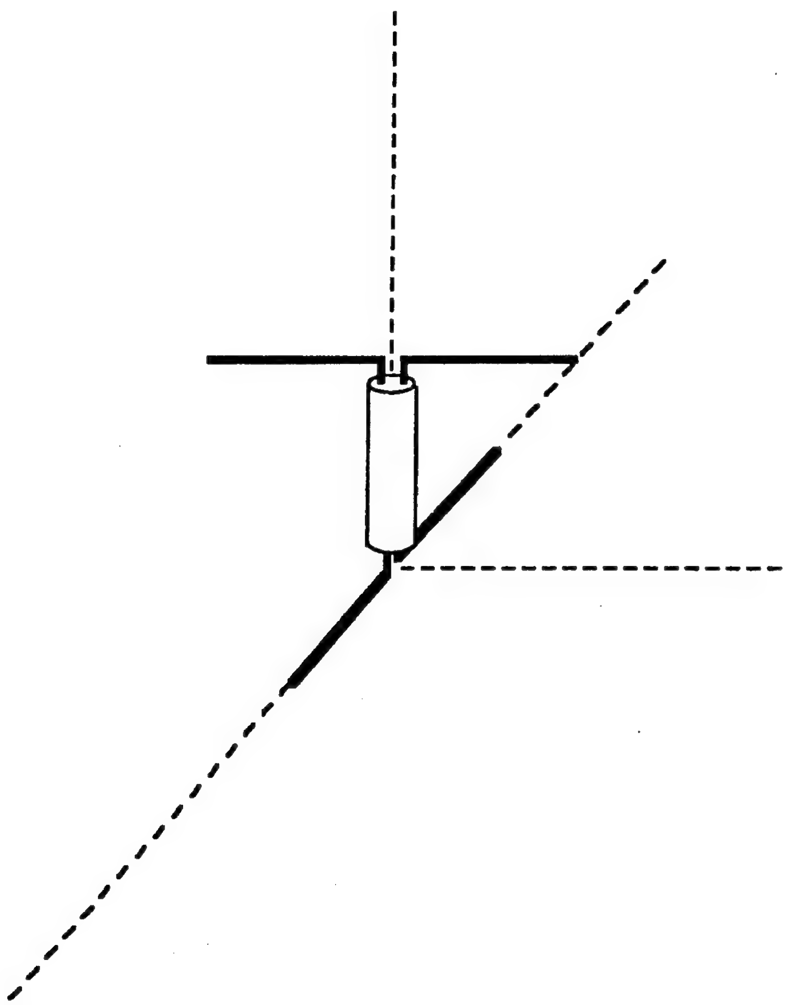

Figure 4. Tilston's CPSS element made of two dipoles and one transmission line.

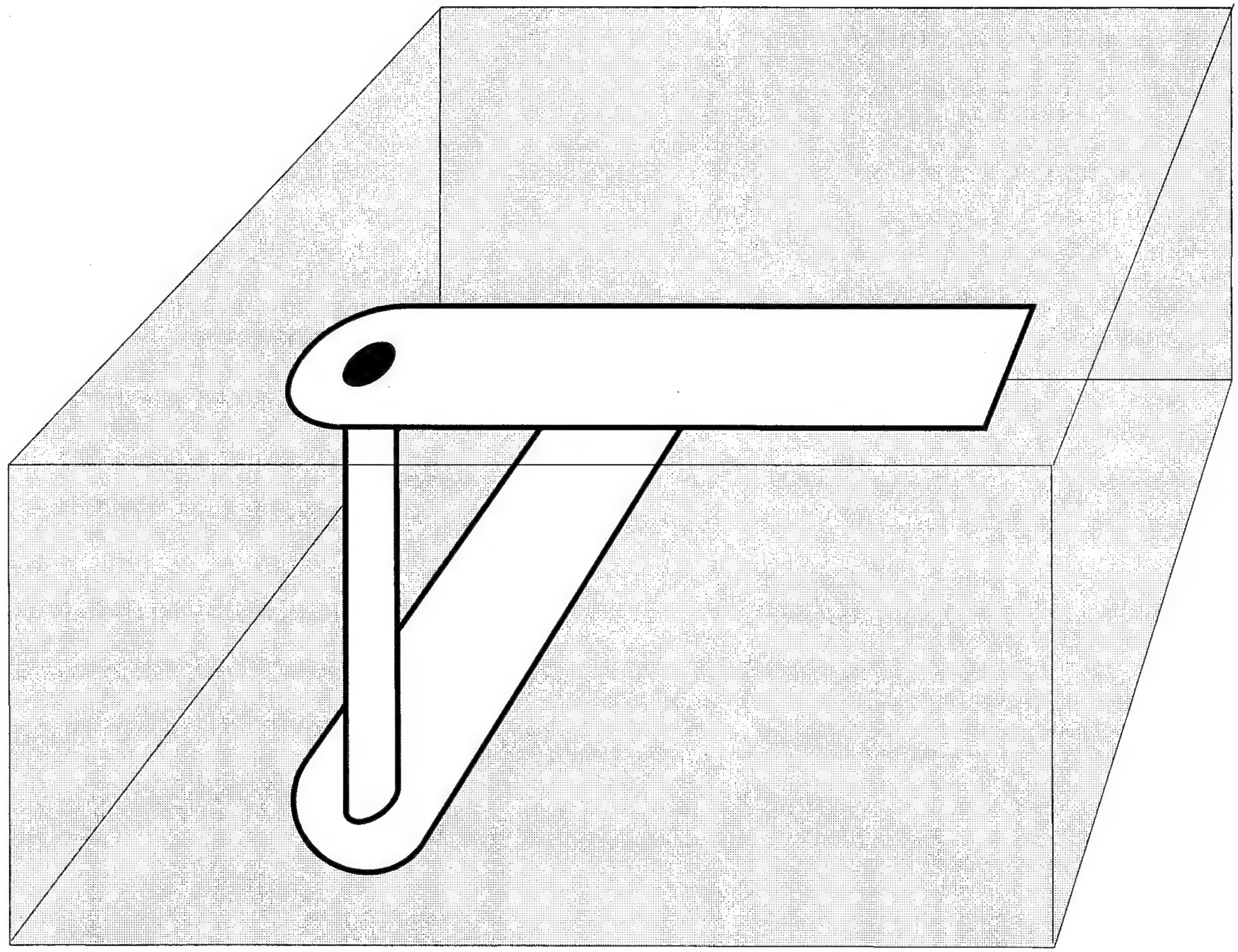

Figure 5. Pierrot's design in microstrip technology.

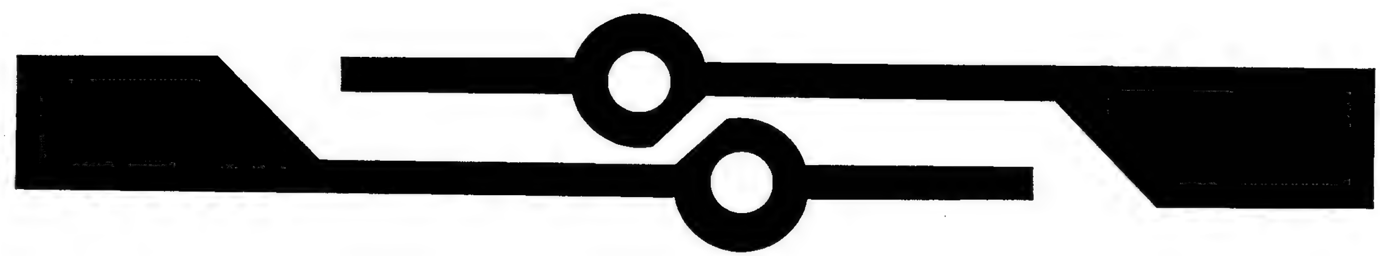

Figure 6. Adaptation of Tilston's design in microstrip technology using a built-in transmission line..

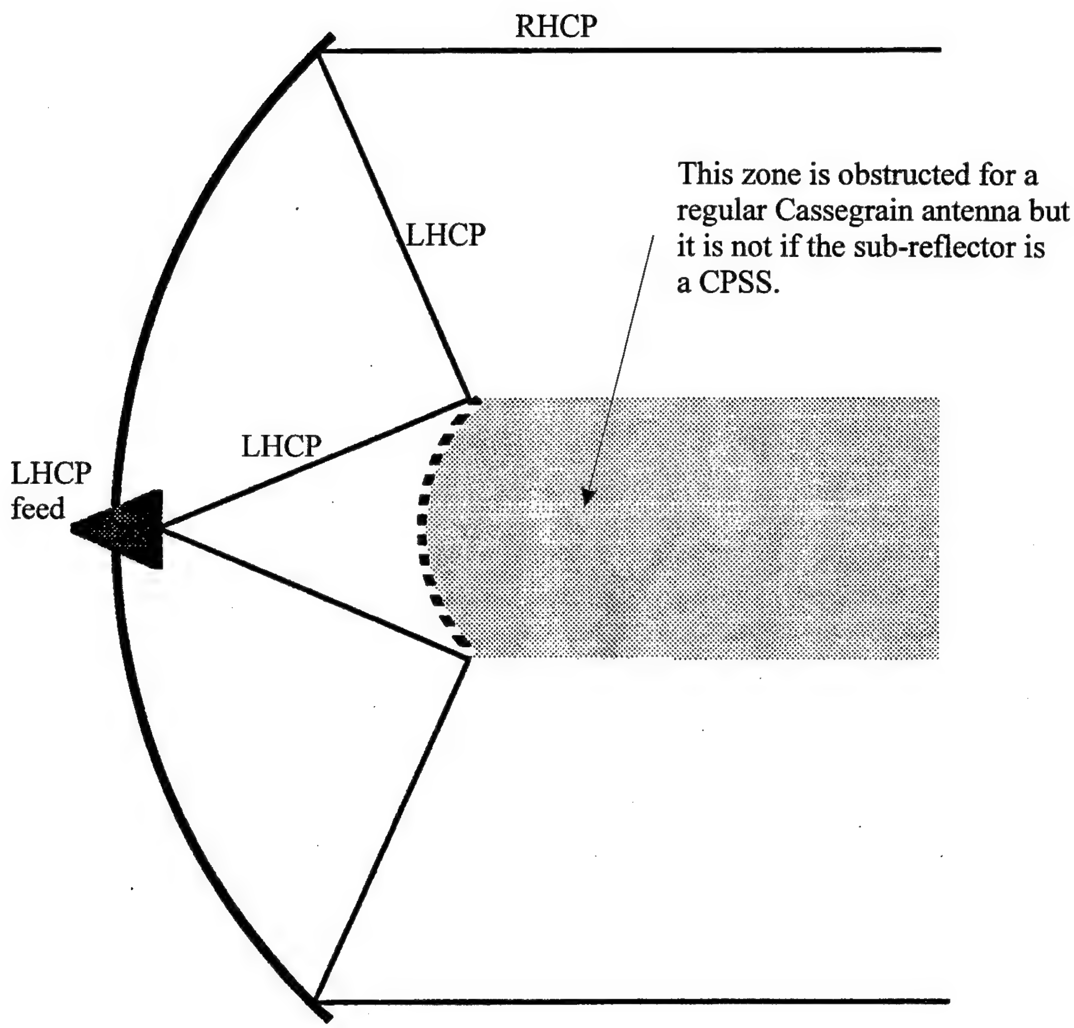

Figure 7. Circularly-polarized Cassegrain antenna with a CPSS sub-reflector.

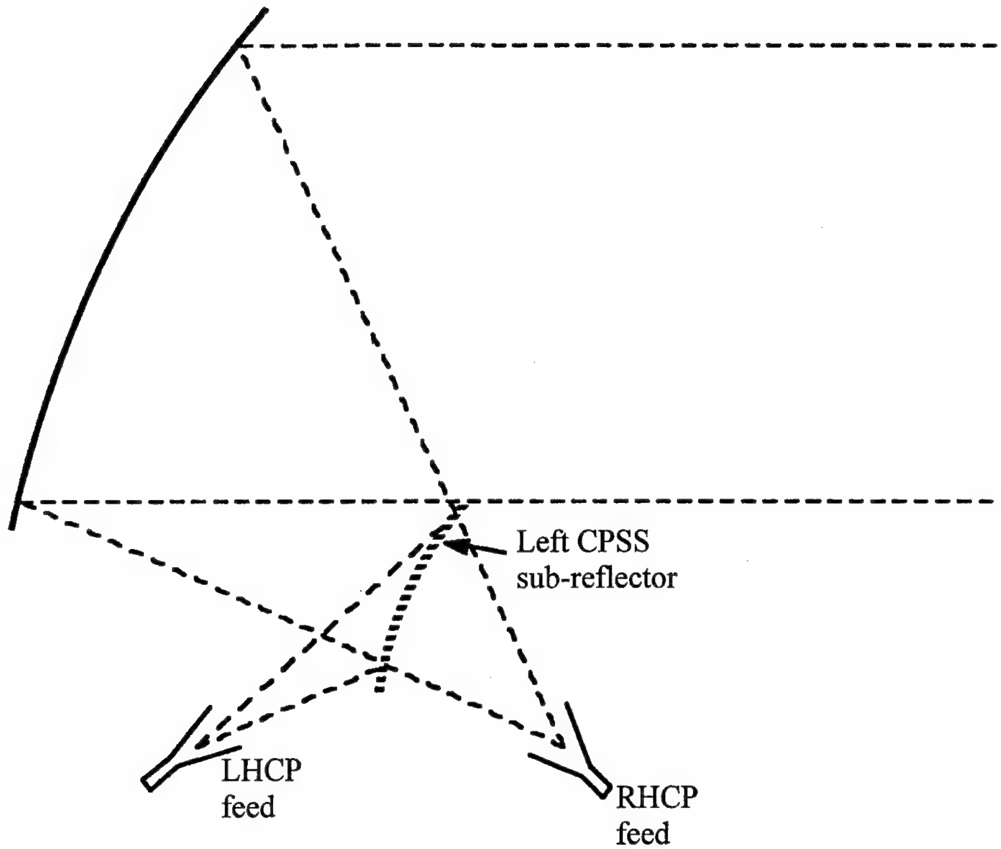

Figure 8. Frequency reuse by polarization-diversity for a CP antenna using a CPSS sub-reflector..

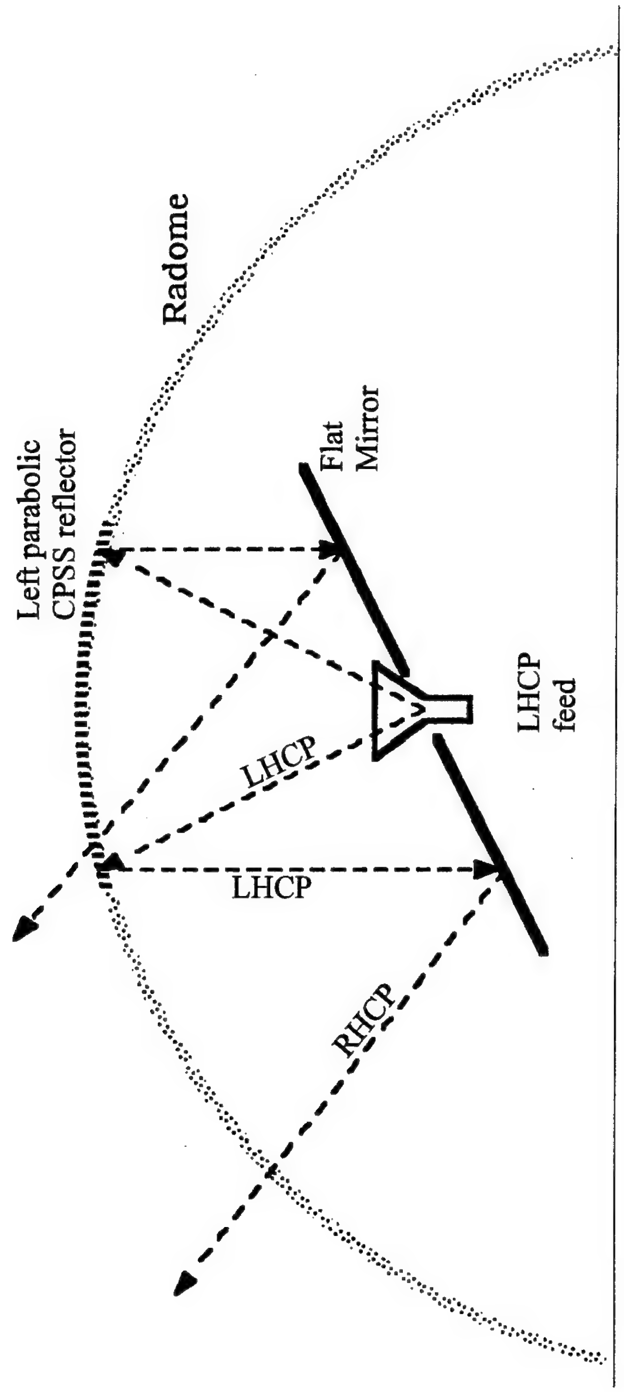

Figure 9. Mirror antenna using a CPSS reflector.

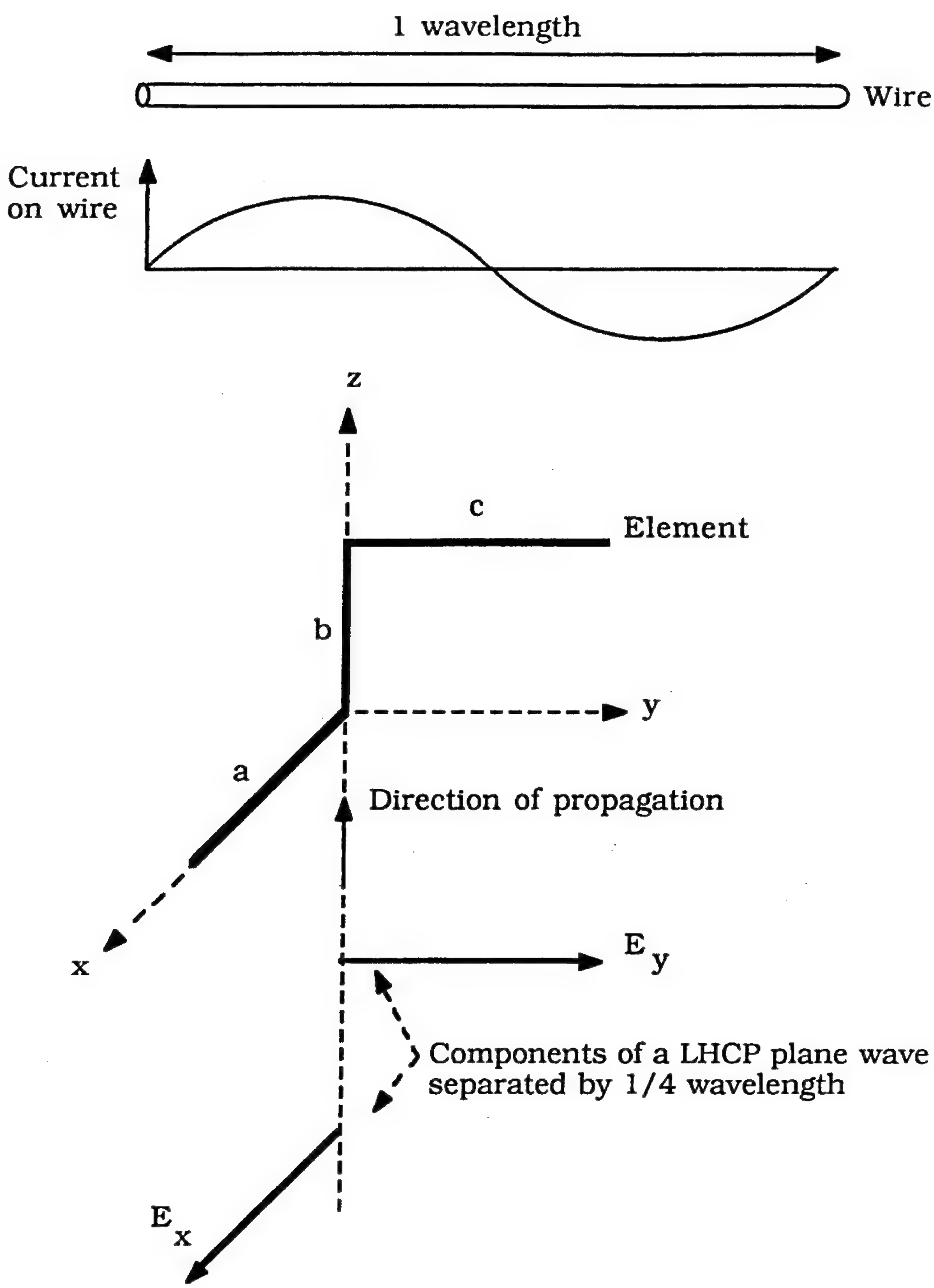

Figure 10. Full wavelength resonance of a left CPSS element.

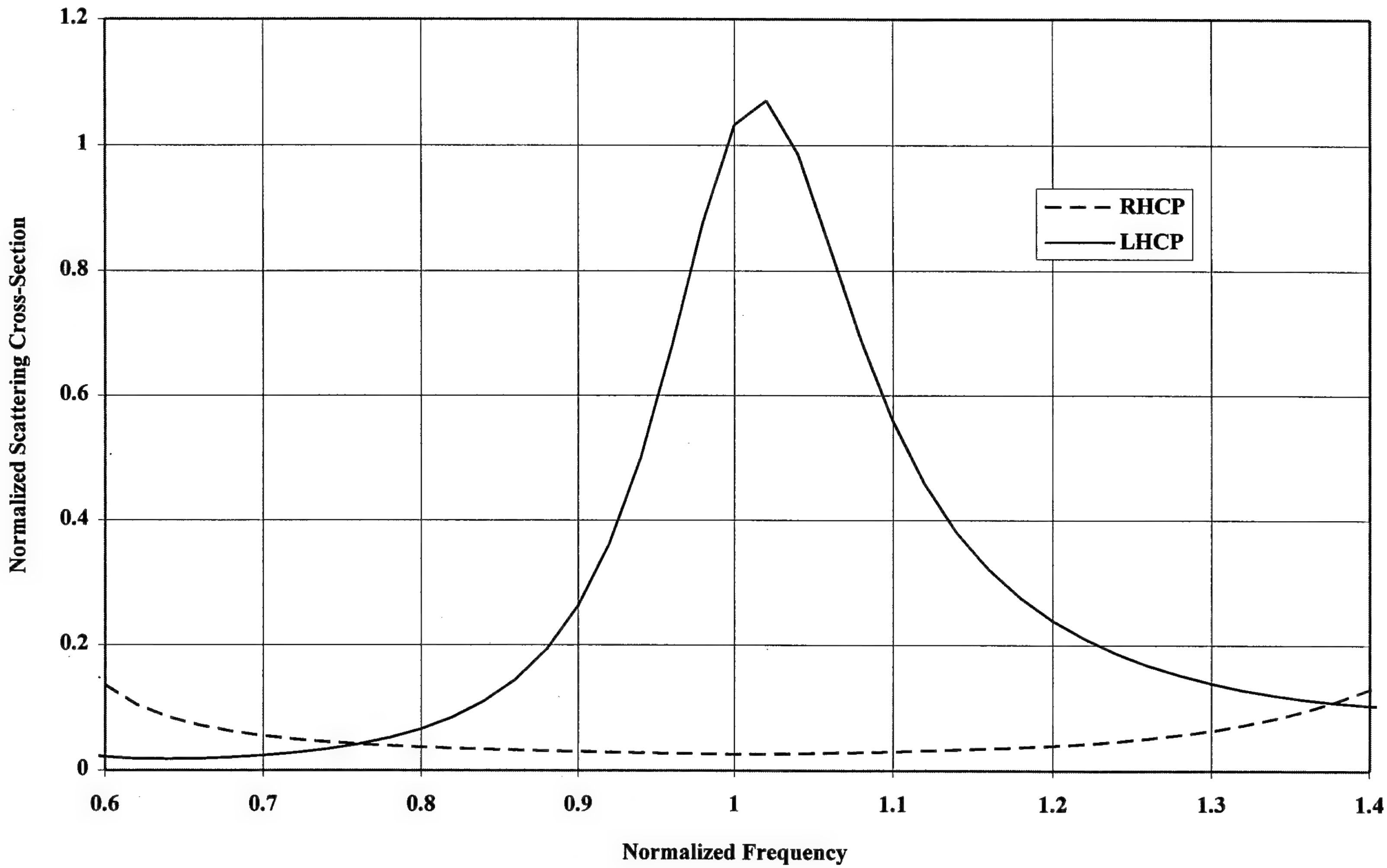

Figure 11. Scattering Cross-section of a LHCP Cell Element

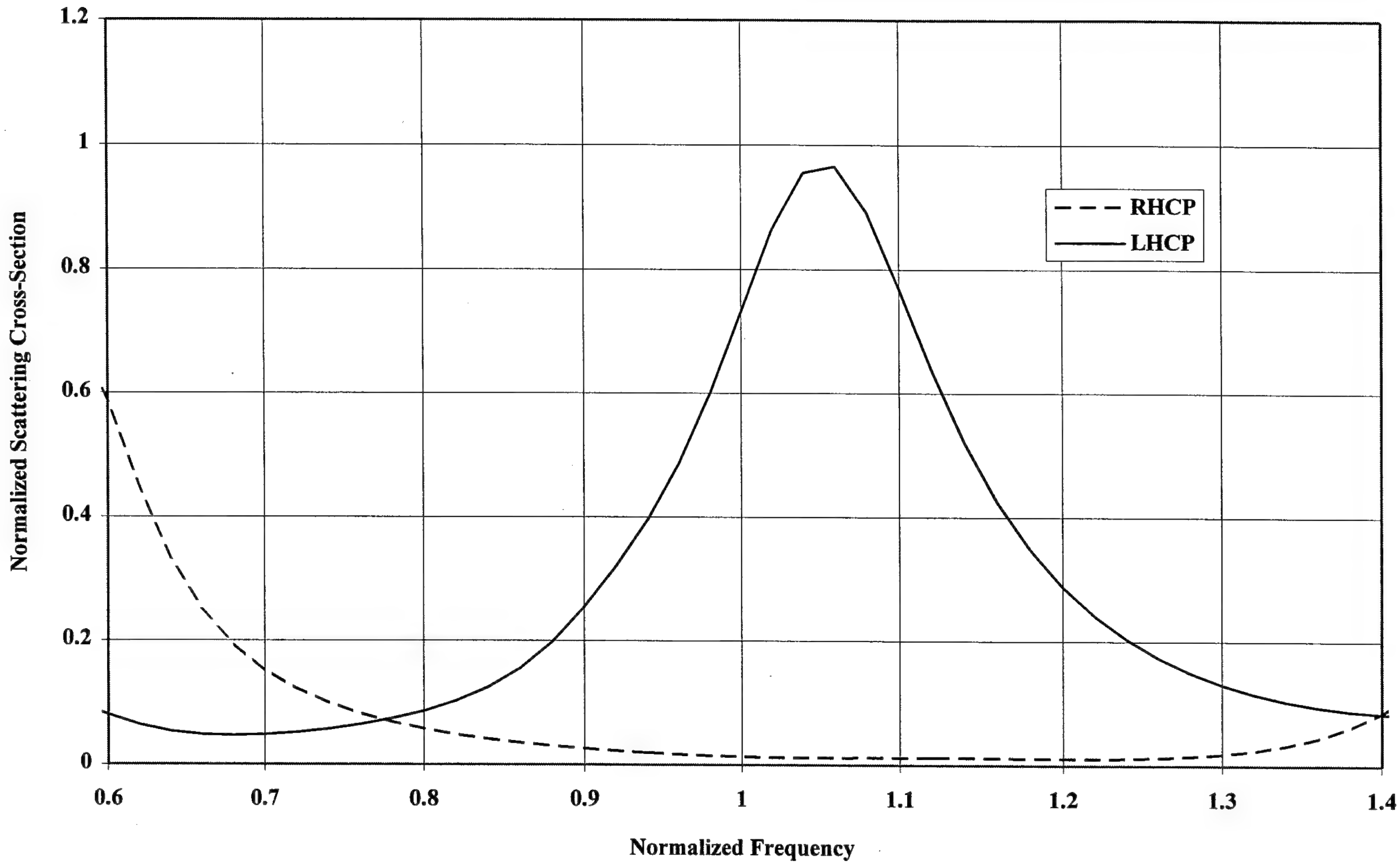

Figure 12. Scattering Cross-section of a 25-Cell Left CPSS

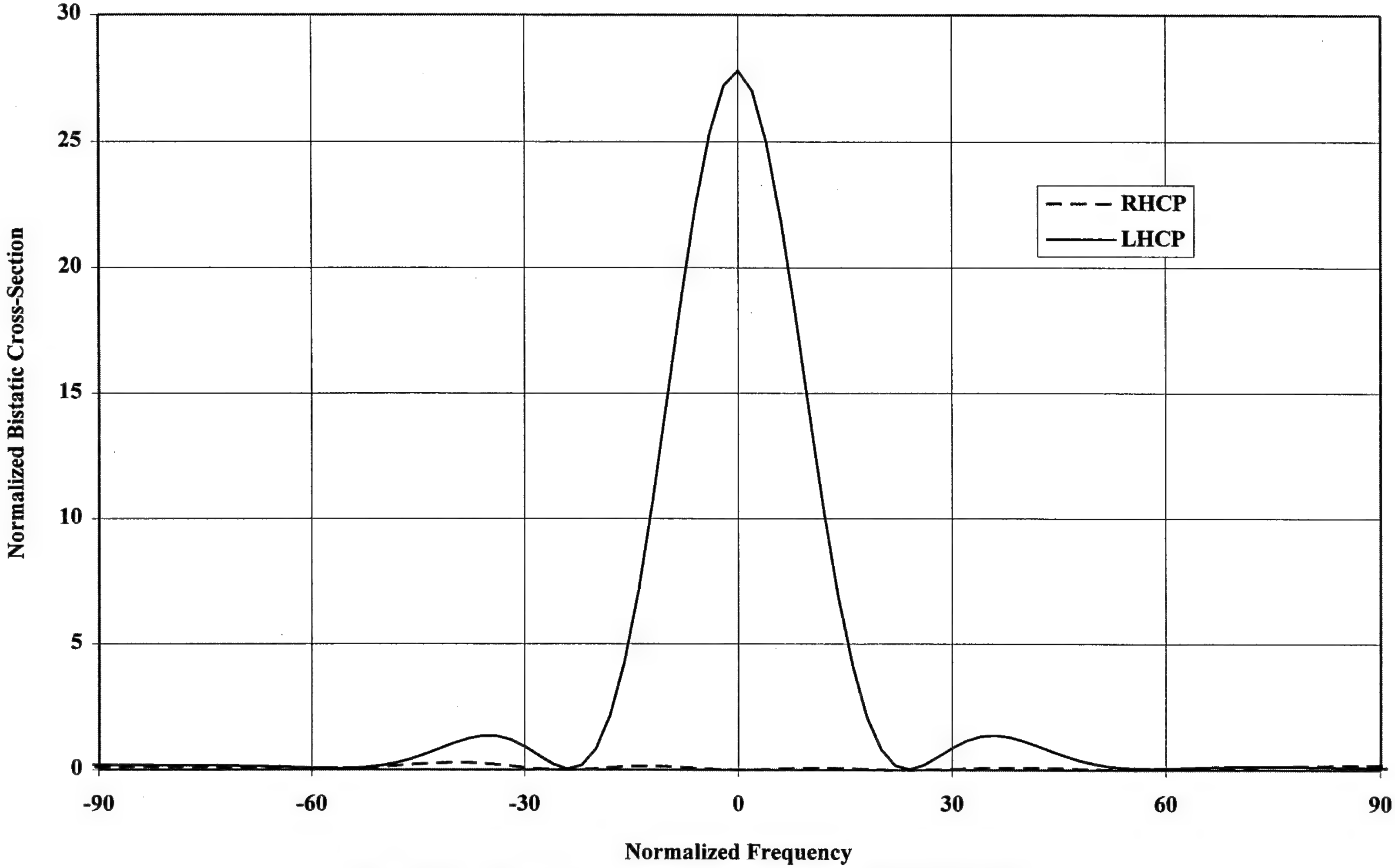

Figure 13. Bistatic Cross-Section of a 25-Cell left CPSS illuminated by an incident LHCP wave normal to the surface. Observation plane: x-y (normal to CPSS) Frequency: 1.0 GHz.

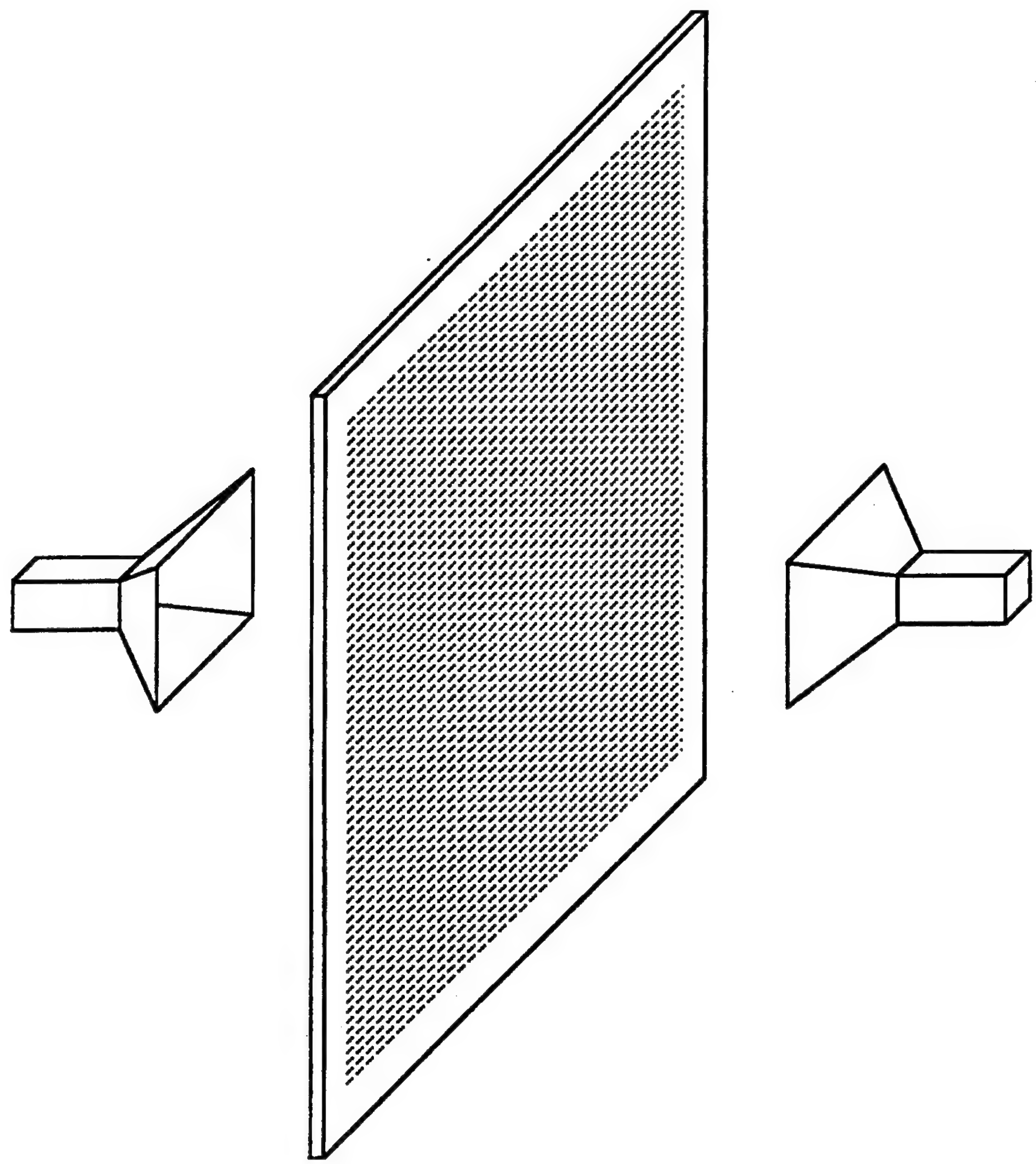

Figure 14. Experimental setup. The horns are quad-ridged horns. Circular polarization is formed using quadrature hybrids.

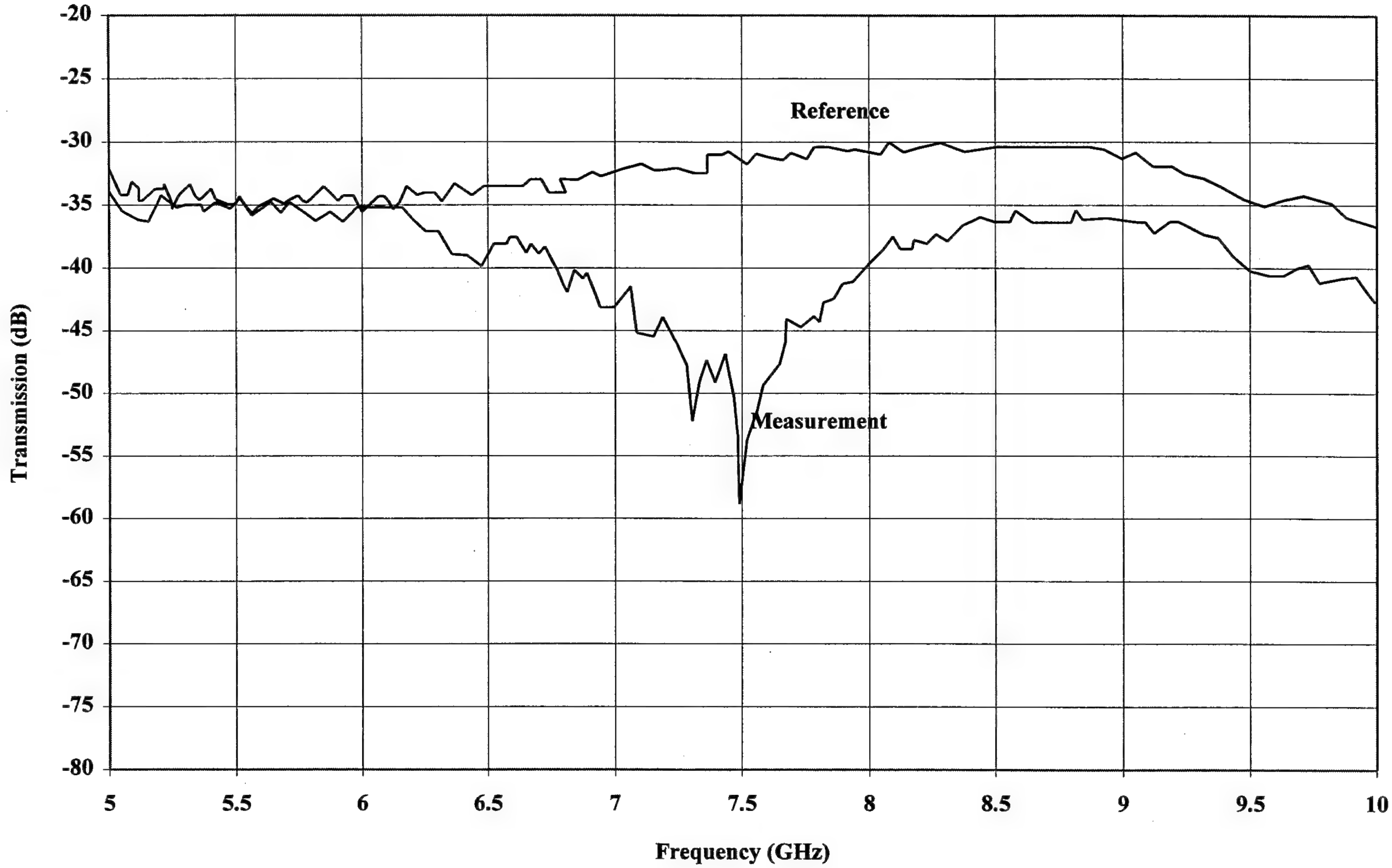

Figure 15. Transmission measurement of a LHCP wave through a left CPSS. The design frequency is 7.5 GHz. The "reference" line is without the CPSS.

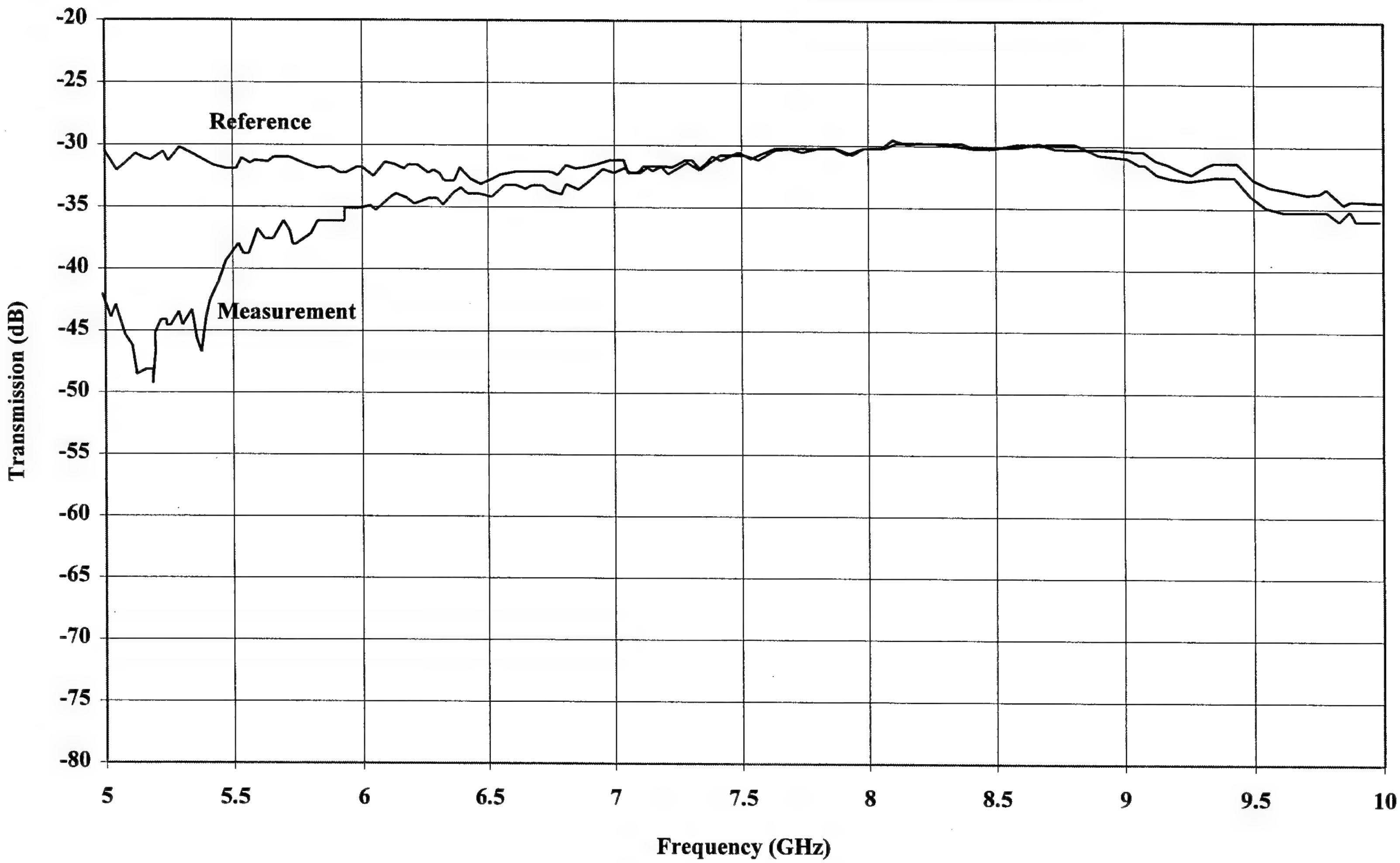

Figure 16. Transmission measurement of a RHCP wave through a left CPSS. The design frequency is 7.5 GHz. The "reference" line is without the CPSS.

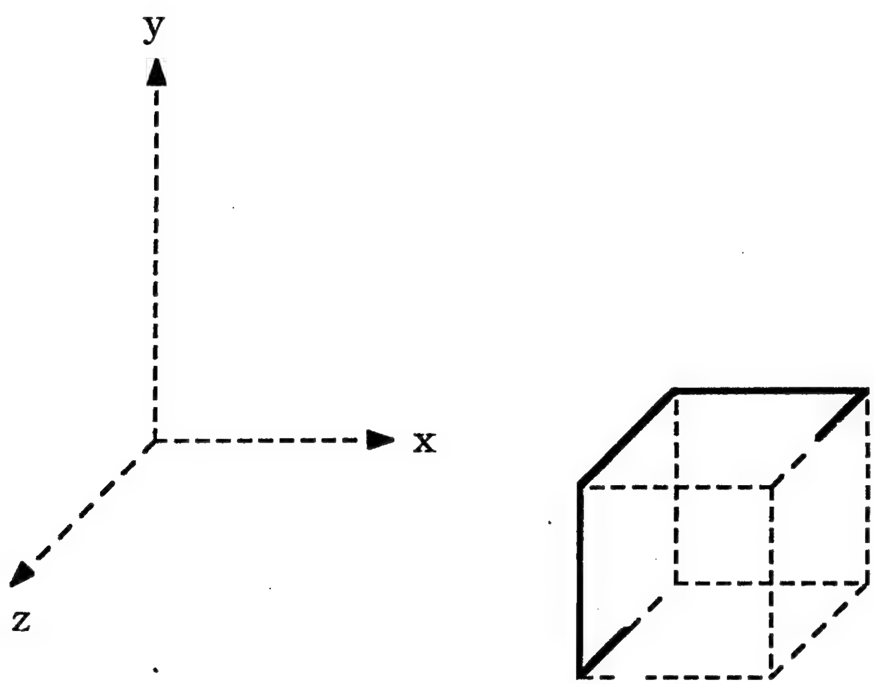

Figure 17. Basic RHCP element for helix.
The total segment length is one wavelength.
Each side of the cube is one quarter-wavelength.

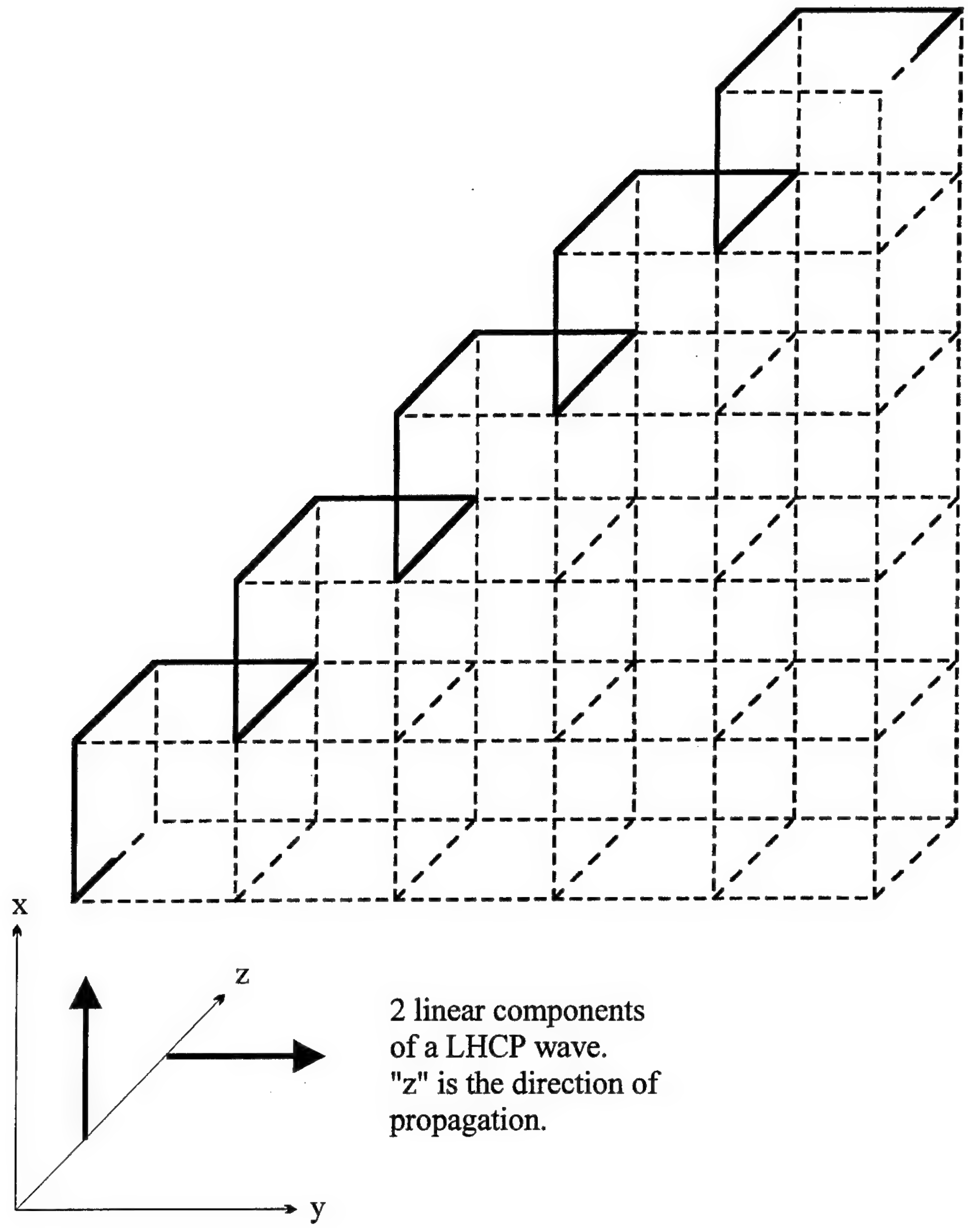

Figure 18. RHCP helix. Each wire segment is one quarter-wavelength.

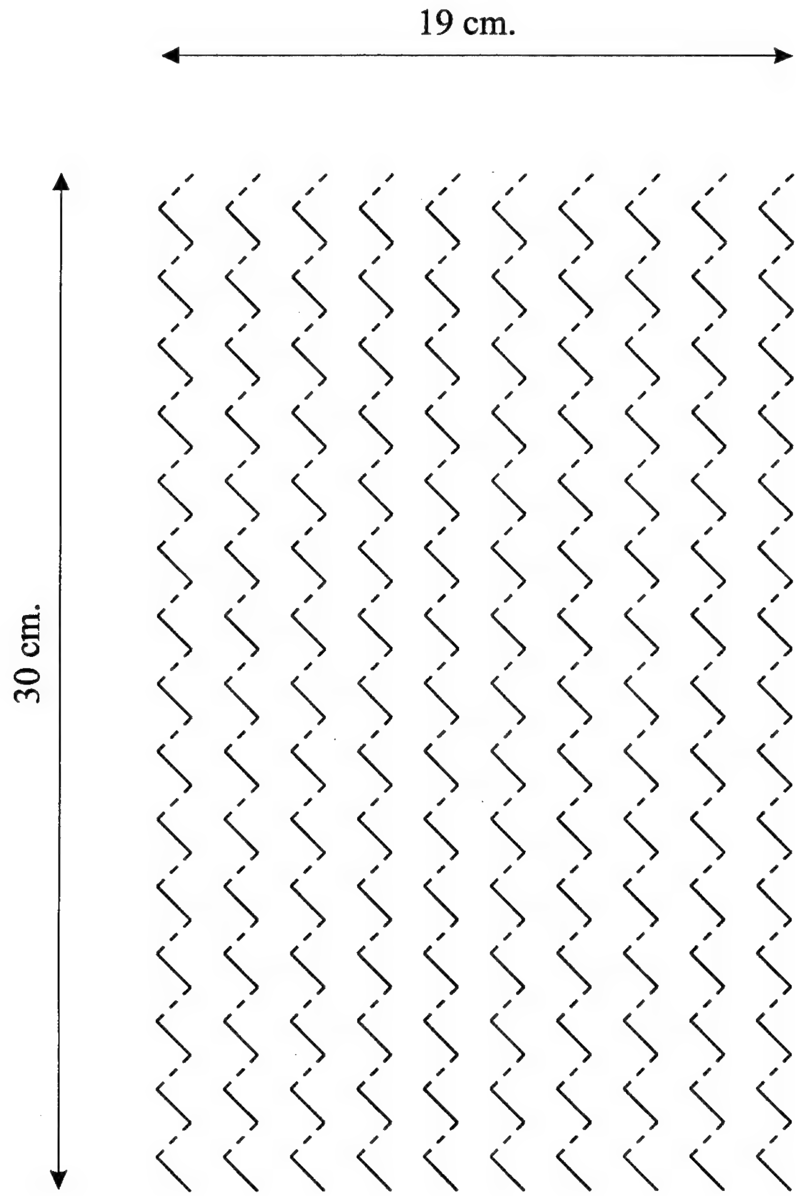

Figure 19. CPSS made of several helices in a plane.

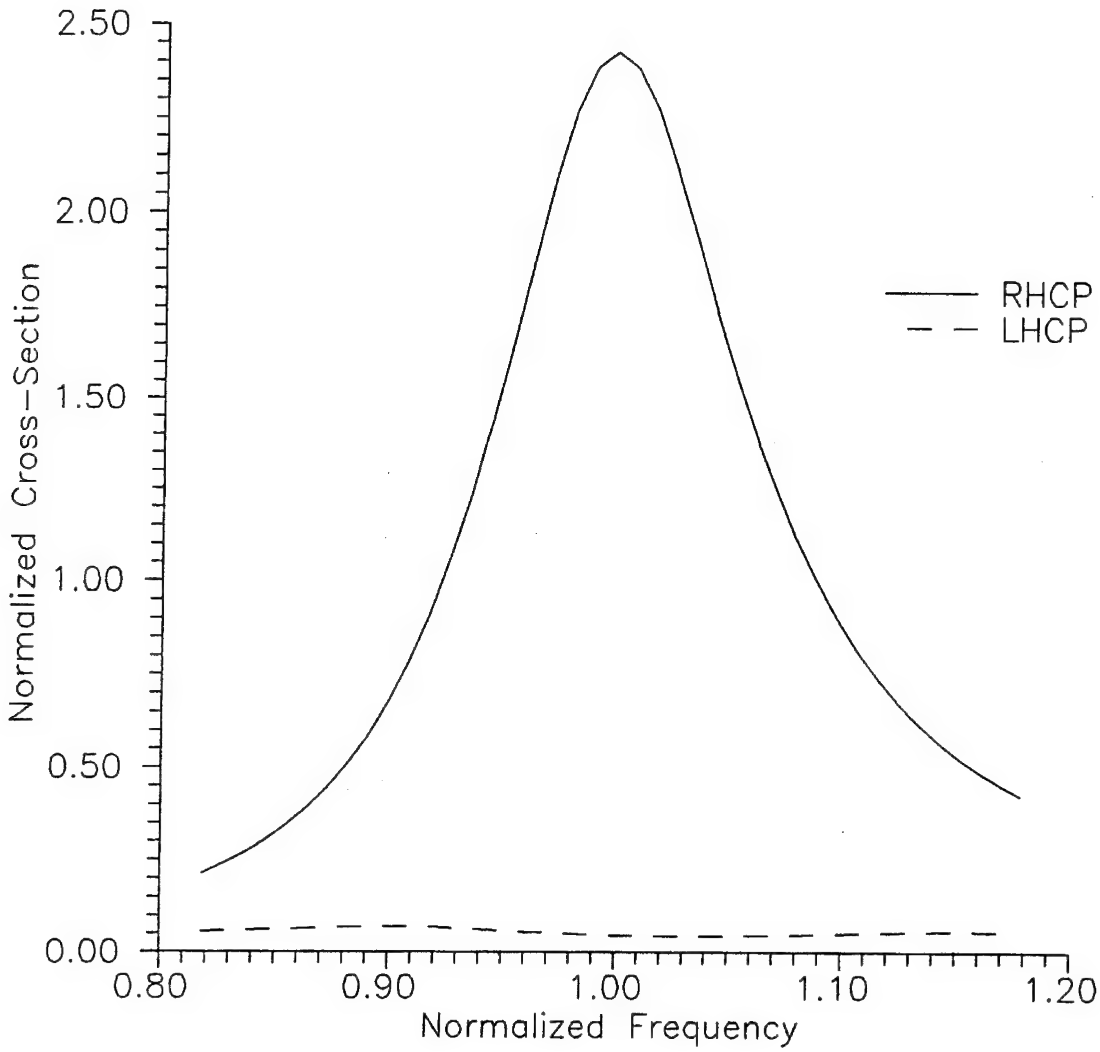

Figure 20. Normalized radar cross-section of a helix.

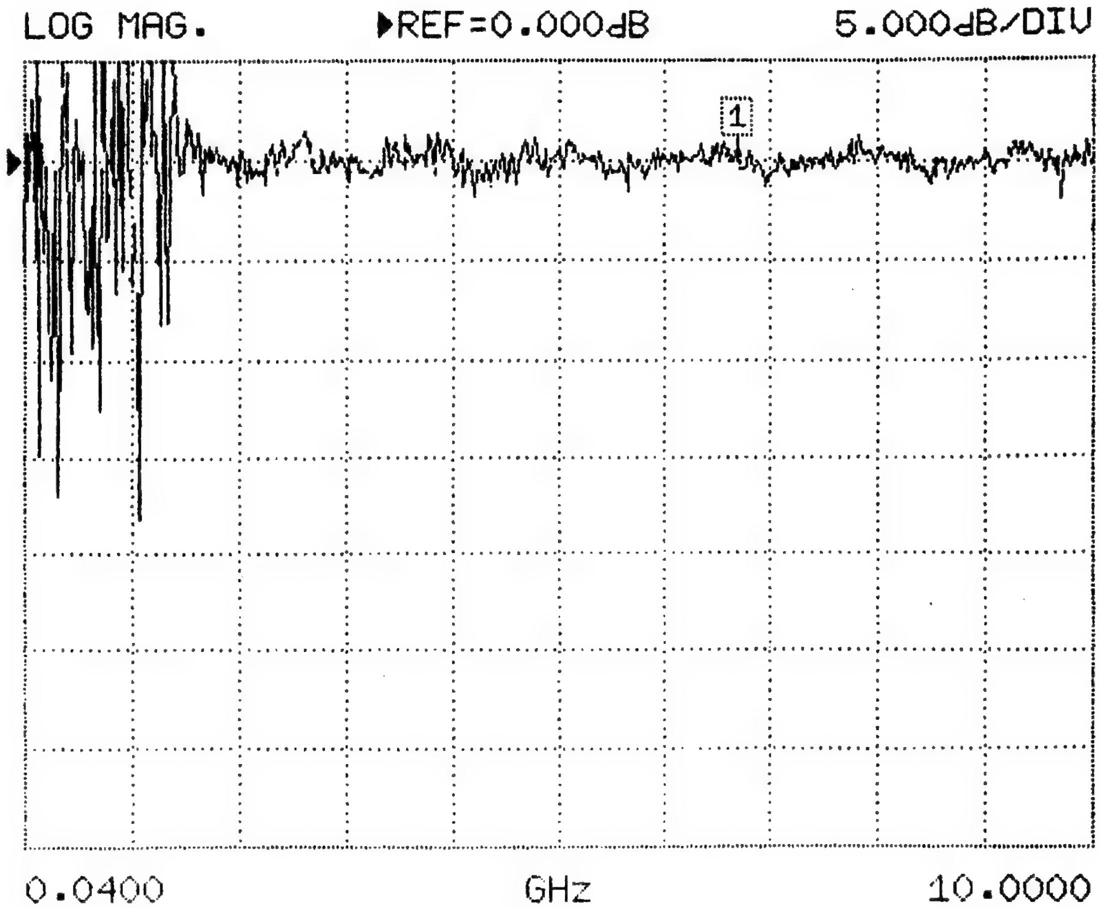

Figure 21. Transmission measurement without any CPSS present. This serves as reference.

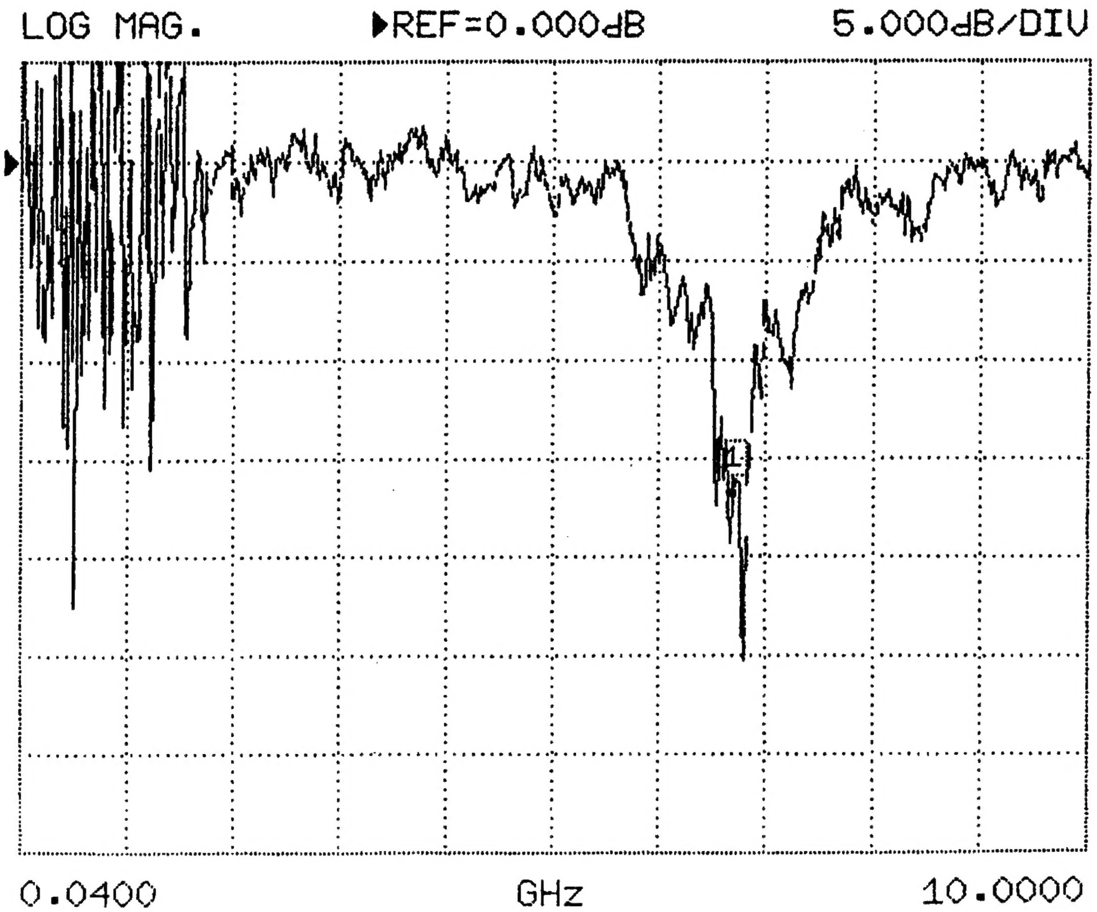

Figure 22. Transmission measurement of LHCP wave through a left CPSS.

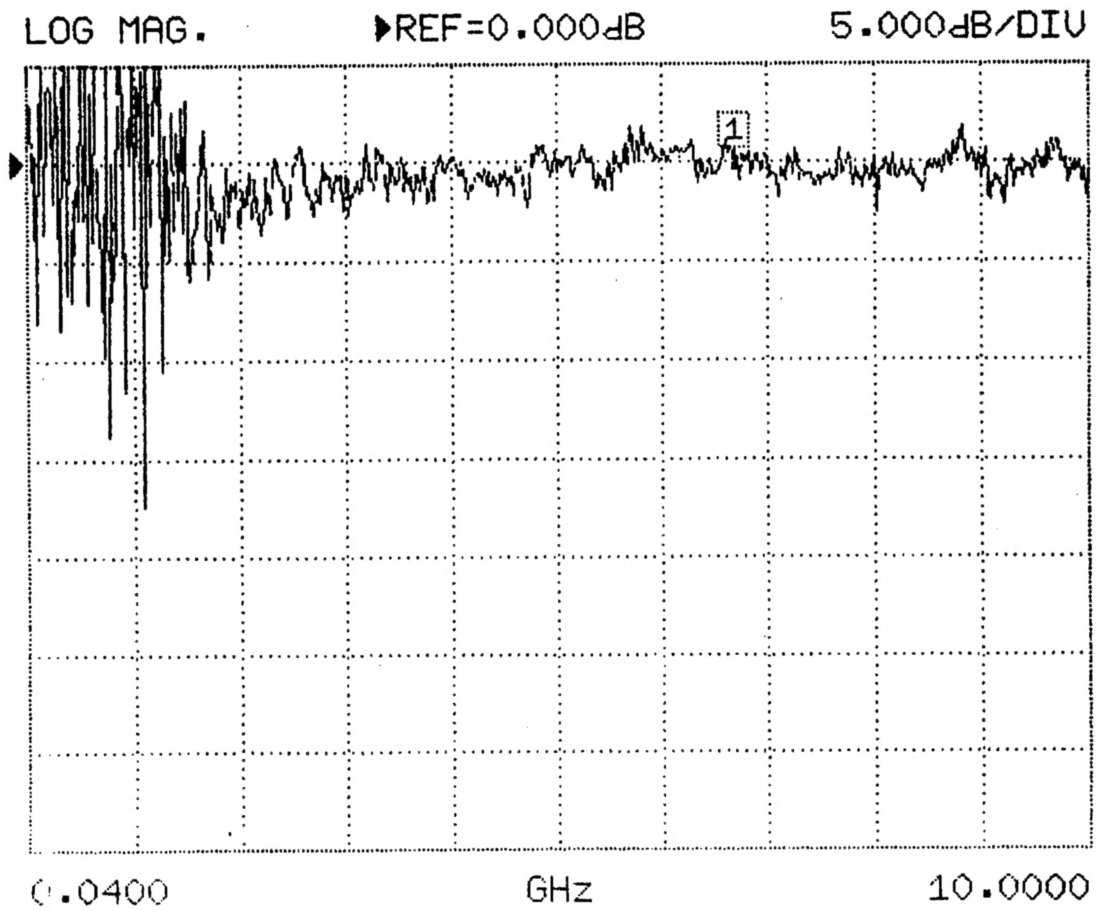

Figure 23. Transmission measurement of RHCP wave through a left CPSS.

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A circular polarization selective surface (CPSS) is a surface that reflects one sense of circular polarization but transmits the other sense. While linear polarization selective surfaces (usually abbreviated PSS) are fairly common, CPSS's have attracted attention only recently. In this report, a new CPSS with improved characteristics is presented and potential applications are discussed.

This new CPSS is made of special square helices. Because the helices can be supported at their extremities, this CPSS does not need a dielectric support as other CPSS's do and therefore can be made more transparent.

The response of the CPSS to a plane wave excitation was simulated using the method of moments for thin wires. Mutual coupling and losses were taken into account. Simulation results show that the radar cross-section of the surface to one circular polarization is 50 times higher than to the other polarization.

A CPSS has been fabricated. Transmission measurements show that the surface permits most of one circular polarization to pass through while rejecting the other polarization. The rejection ratio is more than 15 dB. These results are in good agreement with the theory.

Three potential applications of CPSS's in the field of reflector antennas are reduction of sub-reflector blockage in dual reflector antennas, frequency reuse through polarization diversity in a dual-offset reflector, and design of a mirror antenna for circular polarization.

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CPSS, Circular Polarization Selective Surface, Circular Polarization Sensitive Surface, Polarization Selective Surface, Polarization Sensitive Surface, Antenna.